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UNIVERSITY OF ILLINOIS

The Brood Diseases of Bees in Indiana and Their Control

APIARY INSPECTION

Bee Diseases.

Diseases of bees fall naturally into two groups, those affecting the brood, or "brood diseases" and those affecting the adult bee, or "adult bee diseases." The beekeeper sustains his heaviest losses from the brood diseases, although at times comparatively large losses occur as the result of adult diseases.

Brood Diseases.

There are three well known brood diseases of bees. In order of their importance they are American Foul Brood, European Foul Brood and Sac Brood. All of these are quite prevalent in Indiana.

American Foul Brood.

American Foul Brood is by far the most serious disease found in Indiana, and is the most difficult to combat. It is a bacterial disease, the causative organism being known as *Bacillus larvae*, which, while certain death to developing bees, is not harmful to man's health. It is one of the greatest factors in the beekeeper's cost of production.

Review of the Year.

It has been shown by our experience in inspection work in Indiana that this disease can be controlled by treating and area clean-up methods and it can be entirely eliminated in a locality by a solid community effort, after an educational campaign. This has been done in parts of Indiana but it takes time and money for this work as well as the co-operation of the beekeepers.

Plan of Work.

A good plan which we have pursued in most sections during the past year has been to organize the beekeepers of the county and then with their help search out and inspect every apiary and every hive in the diseased area. Care was taken to make sure the owner of diseased hives either treated them at the proper time or destroyed them. This was done by the use of a system of form letters and blanks used for the first time in the fall of 1931. The owner of diseased hives was required to make a report to the office of the State Entomologist when this work was done. It is believed the letters and blanks sent out following the inspection is one of the best means to get the owner to busy himself and clean up at the proper time what has been marked for him. A further re-check of all diseased yards was made at a later date when the honey-making season was over and it was too late to treat. At that time, all new cases and left-over cases of American Foul Brood

were killed and carefully burned by the inspectors wherever the owner had failed to do anything. It was gratifying that few left-over cases from the first inspection were found on the second inspection.

This plan, which has been used in a limited way for a number of years, was used almost exclusively for the past two years. It has proved its worth, for there is less work connected with the inspection after an area has been cleaned up, but the work must be followed up each year, as infection may reappear at any time, often again introduced from some outside source.

The bad economic condition on the farms which has been so noticeable for the past two years has not been without its compensations. Although farmers are doing their work with as little help as possible and it was expected that many of them would neglect their bees, thus placing the burden of destruction of any diseased colonies on the inspectors, it has not worked out that way in many cases. Some took better care of their bees than usual, seeming to feel that there was more clear money to be made with their bees than with other farm pursuits. It is true that the lack of funds retarded the work of saving the bees somewhat as many did not have the cash to buy foundation and other equipment to treat their bees. Consequently those who did nothing with their disease had it destroyed for them under the expert hands of the inspectors, and those who felt cramped for funds decided to take the easiest and quickest way out by killing and burning all their diseased colonies. This, of course, saved the inspectors the trouble; besides where the work was done carefully the apiary was rendered free from disease. It is believed that, although these particular colonies were not saved, more bees will be saved in the long run by preventing a further spread. It is believed also that better results would generally be obtained by those who do not understand treating disease if more of the owners would carefully kill and burn all colonies diseased with American Foul Brood.

The General Trend Toward Careful Burning of American Foul Brood.

In fact, it has been noticed that here in Indiana as in other states, where the beekeepers are given their choice of treating or burning, the general tendency is toward burning rather than treating. The owner may try treating at first or for a year or two and may succeed, but if he makes a few costly mistakes or fears he may have some reoccurrences he turns from treating and appears glad to burn any diseased colonies at once. He often finds it cheaper and less trouble to kill and burn and clean up the equipment which is then filled with new swarms, artificial increase or package bees bought from the South. In fact, disease is detected and destroyed by the owner in many instances before the visit of the inspector. In general, beekeepers have been very much interested in the clean-up work and have rendered splendid co-operation at all times. Many of them have been glad for an opportunity to accompany the inspector to learn to recognize the brood diseases and to know much more about each for their own protection. They have been of invaluable aid to the inspector, making his work more efficient by locating neglected apiaries and piloting him to them, by opening and closing hives, lifting

heavy supers, running the smoker, etc., while the inspector did the more technical work of looking at the brood. This saved the time of the inspector and money for the state. Beekeepers rendered a total of five hundred three free days of work and piloting during the year. They also furnished a total of one hundred sixteen free meals and seven free days' driving with an automobile.

The per cent of A. F. B. colonies found increased slightly over last year or from 6.36% to 6.6%, which is a little less than $\frac{1}{4}$ of 1%. This was to be expected since there were some counties where the beekeepers had lost interest or become lax in their efforts to continue inspection work. These counties were given more thorough inspection and found to be in bad shape. These counties were: Grant, Hancock, Henry, Jay, LaPorte, Rush, Wabash and St. Joseph, besides many smaller areas in other counties. The beekeepers in these areas and counties are now alert to the situation, and since these counties have been rechecked they are now freer from the brood diseases than in years. Since an effort was made to spend the major part of the time of the inspectors ferreting out the diseased colonies or working in the diseased areas where work was needed most, it is believed that conditions in the state as a whole are much improved.

The honey show at the State Fair was equal in every way to that of former years. In all, there were ten honey producers and two dealers who exhibited. Their booths were beautifully decorated and the honey and other products artistically displayed. No finer honey is produced anywhere than in our own Hoosier State and, although in some localities the crop was cut short by dry weather, some of the very finest honey was produced and shown. Unusual interest was shown in the by-products of the apiary, such as wax and honey vinegar. It is believed there are great possibilities for using up surplus off-grade honey or honey contaminated with A. F. B. germs in a safe and sane way by its use in the manufacture of a fine quality of honey vinegar.

The following counties were visited by inspectors during the year 1932. Those headed * were given a general inspection and the others were only entered as they happened to border the ones given general inspection or when a call was made by some interested beekeeper.

*Adams	Fulton	*Lawrence	*Rush
*Allen	*Gibson	*Madison	Starke
Bartholomew	*Grant	*Marion	Steuben
Benton	*Greene	Marshall	*St. Joseph
*Boone	*Hamilton	*Miami	Sullivan
Carroll	*Hancock	Montgomery	Tipton
*Cass	*Hendricks	Monroe	Tippicanoe
*Clay	*Henry	Morgan	*Union
Clinton	*Howard	Newton	*Vanderburgh
Daviess	*Huntington	*Noble	*Vermillion
*Dearborn	Jackson	Ohio	Vigo
*Decatur	Jasper	Owen	*Wabash
DeKalb	*Jay	Parke	Washington
*Delaware	Johnson	*Pike	Warren
*Elkhart	*Knox	*Porter	*Warrick
*Fayette	*Kosciusko	*Posey	*Wayne
Floyd	LaGrange	Putnam	Wells
Fountain	*Lake	Randolph	White
Franklin	*LaPorte	Ripley	Whitley

STATISTICAL REPORT FROM OCTOBER 1, 1931, TO SEPTEMBER 30, 1932.

Number of apiaries inspected.....	7,310
Total number of colonies inspected.....	65,045
Number of live colonies inspected.....	62,183
Number of dead colonies inspected.....	2,862
Live colonies found diseased with A. F. B.....	2,993
Dead colonies found diseased with A. F. B.....	1,291
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Total number A. F. B. colonies reported.....	4,284
Per cent of colonies found diseased with A. F. B.....	6.6%
Live A. F. B. colonies burned by inspectors.....	886
Dead A. F. B. colonies burned by inspectors.....	681
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Total A. F. B. colonies burned by inspectors.....	1,567
Number of A. F. B. colonies treated by inspectors.....	30
Total number cases of A. F. B. found by inspectors.....	74
Number of cross-comb colonies found by inspectors.....	2,411
Number of cross-comb colonies transferred by inspectors.....	22
Demonstrations given by inspectors.....	23
Beekeepers' meetings attended.....	83

AMERICAN FOUL BROOD

Name and Origin.

The name American Foul Brood (hereinafter referred to by the initial letters A. F. B.) was chosen because it appeared that this disease was first subjected to a thorough investigation from the bacteriological standpoint by an American investigator, Dr. White, while the other serious brood disease now known as European Foul Brood, hereafter referred to as E. F. B., had been investigated previously in Europe. These names are therefore not intended to convey the idea that the diseases originated one in America and the other in Europe, for the honey-bee is not native to America. The names were chosen simply that beekeepers might have names which could be used with safety. Both diseases have existed in the Old World for centuries and are of more recent importation into this country.

Symptoms.

The general symptoms and conditions brought about by A. F. B. are discussed under separate headings in order that the reader may be better enabled to study the different phases in which this disease manifests itself.

Cappings and General Appearance.

In A. F. B. the symptoms vary within certain limits but are more constant than in E. F. B. The colony may or may not be noticeably weakened, depending upon the age of the case. The colony gradually weakens until death is finally brought about. The brood in an infected colony is scattered and often the cappings are discolored, sunken and punctured. The adult bees often cut away the cappings from the cells after the larvae die. This leaves a large number of open cells which give the well-known scattered or so-called "pepper box" or "polka dot" appearance of the brood. Occasionally not all of the capping is removed so that the remaining part has a ragged appearance. Often the cappings are flat, sunken or not quite the normal convex shape. Sometimes the

whole comb presents the appearance of having been varnished or "oil-soaked" with here and there a very dark-colored capping. However, at times the cappings covering dead brood may appear very much like those covering healthy brood. One or more of these symptoms may be absent, but more often all are combined. The most constant "ear marks" to look for in this disease are those darker cappings interspersed with normal ones, the sunken cappings and those with punctures often no larger than a pin head. It is these cells, whose cappings are darker, perforated or sunken, that should be investigated with a toothpick when the inspection is made.

Age and Color of Larvae.

A. F. B. usually shows in the larvae about the time that it has straightened out in the cell and has begun pupation. At this time it is sealed over in the comb. In very bad cases or where robbing of infected matter has recently occurred, the unsealed larvae may also be affected. The first indication of the infection is a slight brownish discoloration and the loss of the well rounded appearance of the normal larvae. At this stage, the disease is not usually recognized by the beekeeper. It is then not ropy, but only slightly mushy. It rapidly grows darker until a dark chocolate or coffee color is attained. Care must be used to distinguish between the "coffee color" of A. F. B. and the lemon or yellow color which is characteristic of E. F. B.

Position of Dead Larvae.

Larvae dead of A. F. B. will gradually "melt" or sink down in the cells as they become darker in color. They will be found stretched out full length, lying on their backs. Their posterior ends lie against the bottom of the cells. Quite often the shape of the head and tongue will be maintained until the scale period is reached. The tongue which at this stage resembles a small splinter pointing upward frequently adheres to the upper side wall and often remains there even after the pupa has dried down to a scale. This tongue characteristic is often an important item in distinguishing A. F. B. from E. F. B. The tongue characteristic has not been noted in E. F. B. except in cases of double infection. Its presence may be taken as almost positive proof that A. F. B. exists, whatever else may be present.

Ropiness.

By the time it has partially dried down and assumed a decided brown color, the most typical characteristic manifests itself. If a match stick or toothpick is inserted into the decaying mass and withdrawn, the larvae or pupal remains adhere to it and are drawn out in a fine, evenly colored glueish string or thread. This thread is of a silky smoothness in texture and often may be drawn out an inch or two before it breaks. This is known as ropiness and is the chief characteristic made use of by the beekeeper in diagnosing this disease.

Scale Formation.

The larva continues to dry down and gradually loses its ropiness until it finally becomes a scale adhering tightly to the lower side wall of the cell and cannot be easily removed. Unlike scales of E. F. B., these

sticky dead larvae and dried down scales are not removed by the bees to any appreciable degree. They adhere to the cell wall as if glued to it and cannot be removed cleanly without breaking the walls of the cell. The scale form of the disease is often overlooked in combs of dead colonies by the beekeeper. These scales can best be observed when the comb is held with the top inclined toward or from the observer so that a bright light strikes the lower side wall of the cell.

Sex of Brood Attacked.

Usually this disease attacks only worker brood, but occasionally cases are found in which queen-brood and drone-brood are diseased. This is unlike E. F. B. in that in E. F. B., queen and drone larvae are readily attacked, resulting in many queenless colonies.

Odor.

A very characteristic and usually penetrating odor is often noticeable especially on a hot day. This has been likened to the odor of heated glue. This glue pot odor is sickening and repulsive to those who have a keen sense of smell and to such it becomes a valuable aid in detecting badly diseased hives by smelling at the entrance although it might not be noticed where only a few cells are diseased. The "odor test" is usually not so reliable as the "toothpick" or visible test.

Spread.

A. F. B. may be spread in a number of ways, many of which may be summed up as careless beekeeping. Feeding honey from diseased colonies; allowing bees to rob diseased colonies; use of infected materials such as combs, hives and the like which are then switched from hive to hive; working healthy colonies with the same tools or gloves that have been used in a diseased colony without properly disinfecting them; allowing bees to drift from diseased hives into the adjacent healthy colonies while using the "shaking method" of treatment or having the entrances too close together; allowing the bees to rob out the honey or infected material from hives, supers and frames while awaiting the "boiling up" or other processes of sterilization.

While it is true that A. F. B. is often spread unwittingly by the carelessness of the operator and for that reason is termed a disease chiefly of manipulated bees, it is not always the fault of the owner or his manipulations that the disease gains entrance into the apiary. All carelessness which leads to robbing in the apiary should be avoided at all times, but no system of management of the apiary has yet been found which will prevent the entrance of the germs of A. F. B. if the disease is in the neighborhood and not destroyed. Bees naturally rob and the stronger the colony the more likely robbing will occur. Although E. F. B. can be controlled by strong colonies A. F. B. cannot. It is these strong colonies that are most apt to forage far and wide and rob out any exposed honey containing the spores and bacteria of A. F. B. wherever they can find it. It is during the spring and at any period of the year when there is no honey in the fields that these strong colonies will overlook nothing in their endeavor to find honey. They will investigate every apiary within their reach, searching old hives, supers, trees,

etc., and they will very promptly rob out any weak colony located. A hive in which the bees have died during winter as a result of disease or other causes and in which considerable honey may be left, will afford a great feast for robber bees. In all of these activities, the stronger colonies take the leading part. Once infected, the colony of course is doomed and will surely weaken and die unless treated. Unless it is treated or destroyed, it thus becomes a further source of spread.

The greatest spread of A. F. B. is caused by allowing weak, diseased colonies or infected dead ones to sit around in the spring or fall to be robbed out. Old box hives, log gums and cross comb hives are also a great menace, for they cannot be adequately examined for disease, therefore they are spreaders of it.

Isolated cases occur where bees in trees are a factor in the spread of A. F. B., but from a study made of this subject in California where thousands of bee trees were cut in A. F. B. territory under the direct supervision of the bee inspectors we must conclude that this is relatively rare. This conclusion is borne out in Indiana by the hunters of wild bees who state that A. F. B. is almost never found in the combs of bee trees that are cut. Furthermore, A. F. B. has been entirely eradicated from given areas without serious attention to bee trees. There is a very obvious reason for this. When a swarm absconds, carrying A. F. B. honey, and goes into a tree it automatically cures itself by using up the infected honey in building new combs just as it would if put into a hive on foundation. Besides, the combs and honey of swarms weakened by disease in a bee tree are soon consumed by wax moths, coons, bats, owls, ants, etc. "Take care of the disease on the ground and the bee trees will take care of themselves" is an established fact. Bees in old buildings seem to be more of a menace than bee trees but these can usually be taken out or sealed in.

One fact has been well established—that the germ of A. F. B. enters the larva via the alimentary tract through infected honey fed to it. Our chief concern, then, for the control or eradication of A. F. B. is honey from diseased hives. If all diseased brood and honey are immediately destroyed, there is little likelihood of its spread therefrom.

Preventive Measures.

Preventive measures must therefore center around precautions that will prevent bees getting the honey from colonies which have the disease or bringing in contaminated equipment or transferring it from hive to hive. The following rules should be observed:

1. Never feed honey purchased on the open market. In case of doubt as to the source of honey, feed sugar syrup.
2. Sell no honey from diseased hives. Cultivate and supply the home market so that there will be no incentive for bringing in other honey from diseased apiaries to be sold in the neighborhood.
3. In introducing purchased queens, transfer them to clean cages provided with candy known to be free from contamination, and destroy the old cage, candy, and accompanying workers or demand a certificate of health on all shipments.
4. When colonies of bees are purchased, first examine them yourself or see that they are accompanied by a certificate of recent date

from the apiary inspector that no disease has been found in the apiary. It is best to place purchased colonies in an isolation yard for observation for a period of not less than six months before moving them in with other bees.

5. The purchase of old combs, second-hand supplies or second-hand honey cans is dangerous, unless it is certain that they have come from healthy apiaries. If from diseased ones, the proper precautions must be taken to keep them from exposure to the bees until the final complete sterilization, rendering, or treatment is finally accomplished.

6. Co-operate with the members of your county and State Beekeepers' Association and your State Inspector of Apiaries in an effort to get an "area clean-up" in your locality.

7. Know disease. Study the symptoms of foul brood and if possible get some first-hand experience with the disease by accompanying the inspector or by visiting neighbors who have it. Then inspect the brood of your own colonies at frequent intervals and promptly eradicate any disease that appears.

8. Avoid the things in your apiary management that will train your bees to rob.

9. Tolerate no weak colonies.

10. Allow no dead colonies to sit open or exposed within range of your bees.

Treatment for American Foul Brood.

It is possible under very favorable conditions to treat A. F. B. by transferring the bees without any honey to clean fixtures in which they are forced to build all new combs before they can rear brood. The method of doing this has become known as the "shaking treatment" and Indiana beekeepers have been very successful in its application, but in the hands of a careless operator it results in the spread of the disease to other colonies through "robber bees" and the drifting of the treated bees laden with the infected honey into the adjacent hives where their load of honey gives them a free pass. The treated bees must be made to use up or digest the infected honey in building new combs. If any of the infected honey is stored, disease will be carried over only to break out sooner or later. It is therefore advisable to make the "double shake" which has long been advocated in Indiana but seldom practiced.

Preparations.

In either case, there are certain preparations that are necessary and advisable. The queen in the diseased hive should be hunted out and clipped or caged beforehand. In case the queen is not clipped, an excluder or a queen and drone trap should be used to prevent absconding, which is quite likely to occur when there is a dearth of nectar or where only starters of foundation are used as in the "double shake" plan.

All implements that will be needed, such as queen and drone trap, hive tool and lighted smoker, should be in readiness before the operation is begun. A complete hive with frames must be in readiness, as well as a tightly closed hive body or box (some beekeepers use double thickness gunny sacks) in which to put the contaminated combs after shaking, or, better still, have the pit dug and the fire burning in which the burning

of the combs is to take place. A runway should be provided for the bees as they enter the new hive. This runway and the ground where the bees are shaken should be covered with newspapers. The frames should be filled with full sheets of foundation properly wired in, if only a "single shake" is given, and with one-inch strips for the first two or three days, if the "double shake" is practiced.

In case the treatment is to take place in an apiary where there are other colonies, it is advisable to move the *healthy colonies*, so that no entrances are closer than ten feet. This should be done several days in advance, so that the moved colonies may become located before the actual operation begins. Under no circumstances should the diseased colonies be moved unless they are taken to a hospital yard more than a half mile away. If this is done, no bees must be allowed to escape from the diseased hive in or near the home yard.

If the diseased hive contains supers of honey or empty combs, the bees should be trapped from them in advance.

Treatment.

When all is in readiness for the actual operation of treatment, the hive containing the diseased colony is lifted from its location and set down three or four feet back or to one side and a new or clean hive with frames filled with foundation is placed on the old location. The diseased hive is then opened, and if the queen has been previously caged, remove the cage and shove it into the entrance of the clean hive. The frames are then removed from the diseased hive and the bees shaken or brushed off onto the newspapers at the front of the clean hive before they are allowed to run into the clean hive the same as in hiving a swarm. When a considerable number have entered, the queen is released from the cage and allowed to enter with the bees. If she was not previously caged, keep a sharp lookout for her and make sure she enters the clean hive at the beginning of the operation or does not crawl under the hive instead. As soon as the old combs and frames are freed from the bees, throw them into the fire or keep them covered from robber bees. The paper on which the bees are shaken must be burned promptly and great care must be taken to prevent the dropping of any honey or piece of comb from the diseased hive.

Saving the Equipment.

If the frames are to be saved, the combs are cut out at once and burned and the ashes covered with earth. The frames and small pieces of super equipment are then at once dropped into a kettle of boiling lye water where they are to be boiled at least twenty minutes. If they are smeared with honey, they should boil thirty minutes or longer. The larger pieces, such as supers and hive bodies, can also be sterilized by boiling in lye water, but this is hard on the paint, and most beekeepers do not have a kettle or food cooker sufficiently large to hold these. For this reason and because it is quickly done, the insides of the hive bodies, supers, covers, and bottom boards must be scorched until browned somewhat. This may be done by pouring a little gasoline or kerosene on them and setting it afire. The fire can be easily smothered out as soon as the parts are scorched enough. There is less personal

danger if a long-handled shovel, rake or hoe is used to turn over the burning part. If preferred, a gasoline blue-flame torch may be used to scorch up the equipment and a good clean job can be done by this method with possibly less damage to the parts, but it takes a much longer time.

In all cases where equipment cannot be sterilized immediately, it must be carried inside where bees cannot possibly reach it, until it is finally made fit for use again.

Caution.

It is advisable to treat only at the begining or during a honey flow, for at such times there is less danger of robber bees from other hives getting into the honey and carrying some of the disease germs home with them. If A. F. B. is found previous to the honey flow, it is best to delay treatment until the honey flow comes on or use the water or "drowning out" treatment. If the disease is discovered late in the season, it is best to kill and destroy or use the water treatment described herein later. If treated out of the honey flow, it will be necessary to start feeding sugar syrup after forty-eight hours and continue feeding until the combs are built. This is thought to force the bees to digest or consume the diseased honey.

The safest plan to follow in treating colonies diseased with A. F. B. is to move all colonies to be treated to a distance of not less than a half mile (preferably farther) from the home yard or from other bees. Then after they have remained there two or three days, or long enough to become accustomed to the location, they are treated and everything cleaned up at once where the treating took place. This method is coming into general use among careful beekeepers. The bees from the diseased hives will return to the home yard only to infect hives there if moved only a short distance or less than half a mile. The treated colonies may be returned to the home yard after a week or so if desired, but this must not be done until they have used up the infected honey carried in their honey sacs which is usually accomplished forty-eight hours from the time of treatment.

Colonies that have become weakened to a noticeable extent are not worth treating. Such colonies should be united with other diseased colonies or entirely destroyed.

Summary of Cautions in A. F. B. Treatment.

1. Allow no robbing of honey from diseased hives when treating or at any time. Expose no honey from the diseased hives.
2. Allow no drifting of bees laden with honey from diseased hives.
3. Use no drawn combs in which the treated bees can store the contaminated honey. No matter where the combs came from or how they have been treated, A. F. B. cannot be cured by shaking bees from diseased hives directly upon such combs. Use foundation.
4. Use no honey from diseased hives to give the bees a start.
5. To prevent the bees from swarming out and leaving in a day or two after they are treated, see that the queen is clipped or else an excluder is placed *under* the hive body next to the bottom board after the queen is in the hive, but bees must not be crushed in doing this.

Many beekeepers use a queen and drone trap or a queen excluding entrance guard in order to retain or catch the queen and prevent the swarm from leaving. These devices should be left on only a few days and when the trap is used, daily attention must be given or the queen may be caught, and, being unable to get back into the hive, may perish.

Disposal of A. F. B. Honey.

This presents a real problem. The safest way is to burn or bury it all. However, if there is a considerable quantity, it may be extracted. This honey must not be fed to bees until boiled, but it is absolutely safe for human consumption. It can be used up in making honey vinegar. If there is a comparatively small quantity it may be consumed in the beekeepers' family, care being taken that none of it is ever placed where the bees can get it.

Such honey should never be sold on the open market. There is always danger that an emptied receptacle will be thrown out where bees can have access to it, thus causing a new outbreak of the disease. If it is desired to feed it back to the bees, it must first be diluted with at least an equal volume of water to prevent burning and then *boiled in a closed vessel for not less than a half hour*, counting from the time that the diluted honey first boils vigorously. Boiled honey cannot be sold as honey. It is good only as a stimulative food for bees and should never be used for winter stores as it would most likely cause dysentery.

The Second Shake of A. F. B.

Some beekeepers, to make sure the bees use up all the infected honey carried over in their honey sacs, prefer to shake the bees first into an empty hive or onto frames or slats containing strips of foundation as above described, and in four days to shake the colony a second time onto full sheets of foundation, destroying all combs built after the first treatment. This insures better combs than the use of strips of foundation, but is a severe drain on the strength of the colony, and the bees are far more likely to desert the hive. Since combs have been treated with alcohol—formalin solution (Hutzelman Solution), the water-formalin solution or the chlorinated water, some of the commercial beekeepers use the treated combs for the second shake after a period of four or more days after the first shake.

Water Treatment of A. F. B.

Many people do not like the shaking or brushing treatment for A. F. B., because of the danger of robber bees while the work is being done. The danger of robbing daily increases as the pastures dry up and the bees have nothing else to do, and any carelessness in exposing infected materials only spreads diseases. For this reason some careful beekeepers resort to the "drown out" method. To treat by the water method, secure from your tinner a tank considerably larger each way than the bottom board of the hive and also taller than the hive to be treated. It is also best to secure a piece of small hose four or five feet long, some ten gallon jars or cans or another tank of sufficient size filled with water to serve as a pressure reservoir. These should be placed on an elevated platform which can be easily built up with boxes or extra hive bodies to a point higher than the top of the hive to be

treated, so that the water can be siphoned over. (If water under pressure and a garden hose are available they may be used instead, if the nozzle is properly adjusted.)

When the preparations are all made, and the bees are all in, the infected colony is set into the tank which should contain only enough water to cover the entrance and keep the bees in. The cover is then removed and the clean prepared hive body with clean cover in place and containing frames of foundation but minus the bottom board is placed on top of the infected hive. No honey or contaminated matter is allowed to touch the bottom bars or lower edges of the clean hive.

It is well to prepare the infected hive in advance by removing and destroying all honey and burr combs that project above the top bars. The brace combs should be cut out so as to make sure the bees can easily reach the clean hive above. It is also a good plan to have strips of thick paper tacked along the top of the infected hive walls or a frame of inch lumber the same size as top of hive to be used between the hives. This will cause only a clean surface to come in contact with the clean hive placed above the infected one. After the infected hive has been placed in the tank and weighted down, water is poured in or siphoned into the tank through a quarter-inch hose. (Fountain syringe hose size works fine.) As the water goes in, the bees and queen begin to crawl upward, and if there has been but little disturbance, they will not have much time to fill up on the infected honey. Care must be taken, however, not to pour the water in too fast or faster than the bees crawl away from it. By the time the tank is filled to the depth of the infected hive, the bees should all be upstairs in the clean hive which should then be lifted off and placed on a clean bottom on the exact spot where the infected hive sat. Bees should not be crushed when this is done. *Caution.* It is well to have an empty hive body sitting on the old location to catch the returning field bees or any that may have escaped when the operation began. The old combs should be destroyed *at once* or removed to a tight building and treated in the usual manner and the hive scorched out. The wet combs will be hard to burn. The water that was used should be poured into a sewer or into a pit and covered over with earth just as are the ashes after burning infected matter. The water and tank used must not be allowed to stand in the yard as it is contaminated by coming in contact with the infected combs and honey, and if it is dry weather, the bees may use it as a watering place. Neither must the combs and frames be exposed or robbing will result.

The water treatment offers a means for a clean and less messy treatment of A. F. B. than the usual "shake out" method, but care must be used in the details of it to achieve one hundred percent cure. It is especially good at a time when robbing is imminent.

Formalin Solution Treatment of A. F. B. Combs.

The use of alcohol-formalin or water-formalin solutions which was looked upon with great hopes a few years ago for the disinfection of diseased brood combs has proved to be impractical from the standpoint of expense and safety except in cases where there are large lots of

combs to be treated and a suitable bee-tight building equipped with sewage or septic tank connections for disposal of the A. F. B. contaminated water used. It has likewise been a failure in the hands of many less careful beekeepers who have failed to uncapped every cell of brood and honey, to remove the honey or to soak the combs the required length of time, to properly safeguard the brood combs and honey while awaiting treatment or to properly dispose of the honey, washings, etc. Formalin solutions do have a great value in the disinfection of all dry combs or doubtful extracting combs before returning them to the apiary.

Alcohol Formalin Treatment of A. F. B. Combs.

The steps for treating combs by the alcohol-formalin solution are as follows:

1. All brood and extracting frames are prepared for treatment by making sure every cell of honey is uncapped (not one cell dare be missed) and run through the extractor, throwing out all the honey possible.

2. The frames are next placed in a water tank and soaked for forty-eight hours. This is for the purpose of diluting the honey yet remaining in the cells. The frames must remain in an upright position either on end or in the same position they occupy in a hive.

3. At the end of the soaking period, the frames are taken from the water tank and as each frame is removed it is shaken in order to eliminate as much of the water as possible. They are then run through the extractor from which all honey previously extracted has been drained into tight containers, and the remaining water is thrown out. At the end of the treatment the extractor must be thoroughly cleaned with steam or scalding lye water.

4. The frames are next placed in the solution tank which is the same model as the water tank except it must have a tight cover to prevent the evaporation of the solution. After the frames are placed into the solution tank, the alcohol-formalin is poured into the tank until it stands well over the frames, which should be weighted down to prevent any part of them from floating above the solution. The lid is then firmly placed and the whole allowed to stand forty-eight hours. It is advisable to jar the tank occasionally to make sure the solution enters every cell. The full time of forty-eight hour soaking and full strength solution are important factors.

5. At the end of this period, the frames are removed and each one shaken in order to get as much of the solution back into the tank as possible. The operator should wear rubber gloves to protect the hands. After shaking, the frames are run through the extractor to further remove any of the solution that remains in them. The accumulated solution in the extractor may be drained out and returned to the regular solution container, along with the solution from which the frames have just been moved, and the extractor cleaned.

6. As the frames are removed from the extractor, each side of the comb is again looked over very carefully to make sure every cell has been uncapped. If any uncapped cells are found, they are uncapped

and filled with pure formalin, using a medicine dropper making sure the material reaches the bottom of the cell. Such combs are put back to soak for awhile.

7. As the frames are removed from the extractor and if found to have no uncapped cells, they are placed in sterilized hive bodies or suitable boxes and stored in a warm room where they are allowed to dry. When they are dry and the odor of formalin has disappeared, they are ready to give back to the bees, but it is advisable to mark them with thumb tacks or in some way and keep full supers together for the purpose of closer checking on the efficiency of such treatment.

The labor involved in this treatment is considerable, and the cost of the solution material almost prohibitive, so that such treatment is not practical for the small producer. *Caution:* Only pure grain alcohol dare be used and this can be obtained only by special Federal Government permit, but the solution can be purchased already prepared.

The Water-Formalin Treatment for A. F. B. Combs.

The steps for treating A. F. B. combs in water-formalin solution are essentially the same as are given above for the alcohol-formalin solution except that the combs must remain in the solution much longer. This is because water has less penetrating power than the alcohol which serves as a carrier for the disinfecting material. The water solution should not be weaker than one part formalin to twenty parts rain water and the combs should soak in this solution not less than fourteen days.

Treatment of A. F. B. Combs in Chlorine Water.

A seemingly more practical and inexpensive method of sterilizing A. F. B. combs was recently announced by beekeeping specialists of the Minnesota College of Agriculture. The treatment is simple, requires no very elaborate equipment, and the cost of material need not exceed two-thirds of a cent a comb, they claim.

The only material difference in equipment in this treatment from other solution treatments given above, is that wooden vats or tanks of stone or porcelain are recommended. For small lots of combs a twenty gallon stone jar will do. This is because the chlorine has a slight corroding effect on metals. Exposed wires, nails and metal parts of hives and equipment will be slightly but not seriously affected. Combs will be brittle when first removed from the solution, but will shortly return to a normal consistency.

Chlorine is the same material used in purifying water in city filtration plants and bathing pools. Chlorine is obtainable in cylinders ranging from 2.5 pounds to 110 pounds or larger. One pound of the gas will make from 60 to 125 gallons of solution. In solution, the chlorine will not harm the skin, but the free gas irritates the nose and throat. The treatment should therefore be given only in screened-in rooms or in the open air when the bees are not flying.

The preparation of the combs for the chlorine treatment as to uncapping every cell of brood and honey, extracting the honey, soaking the combs, etc., is the same as in other solution treatments given above.

This is to make sure the scales that might be under capped or stored honey are exposed to the action of the chlorine.

The combs may then be placed in the wooden tank in an upright position and the water turned in, making sure all parts are immersed. The chlorine gas is then released from the steel cylinders by means of a valve through a rubber tube leading to the bottom of the tank of water. The infected combs are immersed in this solution for forty-eight hours, after which they may be shaken free of the solution, dried until the chlorine odor has disappeared and put back into use.

The spores of the organism which cause A. F. B. are extremely difficult to kill, but the chlorine solution immediately attacks the protein material in which the spores are found. The organism is destroyed in from six to twenty-two hours, but a forty-eight hour immersion is recommended to insure success.

This method has as yet been used by only a few of the Indiana beekeepers but it is too soon to say with what ultimate results.

In general, the plan holds great possibilities for eliminating great waste by saving valuable equipment that is generally burned. If this method can be carried out successfully by those who have bee-tight buildings and facilities for disposal of the contaminated water used, and the area is cleaned up and all further spread of the disease prevented while the treatment is in progress, our goal will be accomplished. The ideal system would be to have all this work done by an expert, qualified and experienced local beekeeper. So far, the chief dangers are the careless transportation of infected combs dripping with honey while in transit to the central treating plant, and its careless exposure while awaiting treatment.

European Foul Brood.

E. F. B., like A. F. B., is a bacterial disease and is caused by *Bacillus pluton*. It usually attacks the larva at an early stage of its development while it is still curled up at the base of the cell. A small percentage of larvae die after capping, in which case sunken and perforated cappings are found just as in A. F. B.

The earliest indication of the disease is a slight yellow or gray discoloration and uneasy movements of the larva and a loss of its plump and opaque appearance. The larva is usually flattened against the base of the cell, but may turn so that both ends of the larva are to the rear of the cell, or may fall away from the base. Later the color changes to a decided yellow and the translucency is lost. The lemon yellow color may be taken as the chief characteristic of the disease. The dead larva appears as a moist, somewhat collapsed mass, giving the appearance of being melted.

When the remains become almost dry, the tracheae sometimes become conspicuous again, this time by retaining their shape, while the rest of the body contents dries around them. Finally all that is left of the larva is a grayish brown scale against the base of the cell, or on the lower side wall, if the larva did not retain its normal position. The scales do not adhere to the cells and can easily be removed.

Decaying larvae which have died of this disease are not usually ropy and when ropiness does occur it is slight and not similar to that

occurring in A. F. B., lacking the elasticity and smoothness in texture. Drone-brood and queen-brood are attacked almost as readily as worker brood.

E. F. B. is more destructive during the spring and early summer than at other times, often entirely disappearing during late summer and autumn.

The most satisfactory method of combating this disease is to keep the colony strong and headed by a strong and vigorous Italian queen of resistant stock. The disease may be treated quite successfully by a system of uniting, then dequeening and requeening, allowing several days' time between the operations.

Sac Brood.

Sac brood is caused by a filterable virus, the specific causative organism not yet having been isolated. The greatest danger from this disease is the chance of confusing it with A. F. B. At first glance these two diseases appear very similar but upon close examination they are easily distinguishable.

The larvae are affected at about the same age in this as in A. F. B. The first noticeable symptom is the loss of the well rounded shape and a dulling of color. The larva lies on the lower side wall of the cell with the outer end which resembles in shape the head of a dried earthworm turned upward, thus assuming what is commonly called a Gondola shape. The color varies from a light gray to a dark brown or black. There is no ropiness. The cuticle or body wall of the dead larva is quite tough and the larva can be removed from the cell intact. Upon breaking through the cuticle one finds the larva to contain a watery granular fluid, having the same appearance as sugar partially dissolved in water.

This disease is usually not the cause of any serious loss in the apiary and in general no treatment is necessary. It is widespread and appears and disappears erratically. It is believed that young, vigorous queens prevent this disease best.